24V/150A MODULAR SWITCHED-MODE RECTIFIER & 18 KW POWERSHELF

PRODUCT MANUAL

C&D TECHNOLOGIES, INC.
Power Solutions

18 Industrial Park Road
Dunlap, TN 37327
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Customer Service, Fax (423) 949-3647
Field Service (800) 873-2707
http://www.cdpowerelectronics.com

PM 990.7520.00, ISSUE 4 FEBRUARY 2001

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C&D TECHNOLOGIES, INC.
Power Solutions

RECEIVING INSTRUCTIONS
&
GENERAL EQUIPMENT INFORMATION

Please Note: For your protection, the following information and the product manual should be read and thoroughly understood before unpacking, installing, or using the equipment.

C & D Technologies presents all equipment to the delivering carrier securely packed and in perfect condition. Upon acceptance of the package from us, the delivering carrier assumed responsibility for its safe arrival to you. Once you receive the equipment, it is your responsibility to document any damage the carrier may have inflicted, and to file your claim promptly and accurately.

1. PACKAGE INSPECTION

1.1 Examine the shipping crate or carton for any visible damage: punctures, dents, and any other signs of possible internal damage.

1.2 Describe any damage or shortage on the receiving documents, and have the carrier sign their full name.

1.3 If your receiving freight bill notes that a Tip-N-Tell is attached to your freight, locate it. If the Tip-N-Tell arrow has turned even partially blue, this means the freight has been tipped in transport. Make sure the carrier notes this on your receipt before you sign for the freight.

2. EQUIPMENT INSPECTION

2.1 Within fifteen days, open the crate and inspect the contents for damages. While unpacking, be careful not to discard any equipment, parts, or manuals. If any damage is detected, call the delivering carrier to determine appropriate action. They may require an inspection.

***SAVE ALL SHIPPING MATERIAL FOR THE INSPECTOR TO SEE!**

2.2 After the inspection has been made, call C & D Technologies. We will determine if the equipment should be returned to our plant for repair, or if some other method would be more expeditious. If it is determined that the equipment should be returned to C & D Technologies, ask the delivering carrier to send the packages back to C & D Technologies at the delivering carrier's expense.

2.3 If repair is necessary, we will invoice you for the repair so that you may submit the bill to the delivering carrier with your claim form

2.4 It is your responsibility to file a claim with the delivering carrier. Failure to properly file a claim for shipping damages may void warranty service for any physical damages later reported for repair.

3. HANDLING

Equipment can be universally heavy or top-heavy. Use adequate humanpower or equipment for handling. Until the equipment is securely mounted, be careful to prevent the equipment from being accidentally tipped over.

4. NAMEPLATE

Each piece of C & D Technologies equipment is identified by a part number on the nameplate. Please refer to this number in all correspondence with C & D Technologies.

5. INITIAL SETTINGS

All equipment is shipped from our production area *fully checked and adjusted*. Do not make any adjustments until you have referred to the technical reference or product manual.

6. SPARE PARTS

To minimize downtime during installation or operation, we suggest you purchase spare fuses, circuit boards and other recommended components as listed on the Recommended Spare Parts List in the back of the product manual. If nothing else, we strongly recommend stocking spare fuses for all systems.

Please refer to the C & D Technologies part number when placing orders. If you seek assistance in filing a claim, please call C & D Technologies and ask to speak with Technical Support.

ISSUE HISTORY

ISSUE	PAGE(S)	DESCRIPTION	DATE
1	ALL	Original Issue	12/28/94 sf
2	ALL	Revised minimum input cable breaker capacity. Revised rectifier test switch operation description. Revised procedure for powering up rectifiers. Updated reference table. Added front panel figure. Revised front panel indicators table. Revised input voltage supply specifications. Revised temperature range and humidity specifications.	6/6/95 sf
3	ALL	Changed throughout manual & cover to read "C & D Technologies, Inc. Power Solutions" and/or "C & D Technologies, Inc.". Changed cover to include Dunlap Plant address, phone #'s, fax #'s, web-site address, etc. Added updated Receiving Instructions & General Equipment Information sheet =issue 7 Added updated drawings & Added Issue History sheet See ECN 12584	MM 10/7/99
4	Chptr 3, Operations & drawing in back of manual	Change/Update "Restarting the Rectifier after a High-voltage shutdown". Replaced drawing PN 111-3785-12 with PN 111-3785 See ECN 13283	MM 4/5/01

DOCUMENT SUMMARY

SCOPE

This manual applies to all C & D Modular Switched-mode Rectifiers that have part numbers that begin with 100-7520, and all C & D Eighteen-Kilowatt Modular Power shelves that have part numbers that begin with 111-3785.

PURPOSE

This manual provides instructions for installing, operating, and maintaining the 24V/150A Modular Switched-mode Rectifier in the Eighteen-Kilowatt Modular Power Shelf.

All statements, information and data given herein are believed to be accurate and reliable, but are presented without guaranty, warranty, or responsibility of any kind, express or implied. Statements or suggestions concerning possible use of the product are made without representation or warranty any such use is free of patent infringement and are not recommendations to infringe any patent. The user should not assume all safety measures are indicated or other measures may not be required.

REFERENCES

Document number	Title
ANSI/IEEE C62.41-1991	IEEE Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits
Bellcore TA-NWT-001089	Electromagnetic Compatibility and Electrical Safety Generic Criteria for Network Telecommunications Equipment, August 1990
Bellcore TR-EOP-000295	Isolated Ground Planes – Definition and Application to Telephone Central Offices, Issue 1, November 1987
Bellcore TR-EOP-000063	Network Equipment-Building System (NEBS) Generic Equipment Requirements, Issue 3, March 1988
Bellcore TR-EOP-000151	Generic Requirements for 24, 48, 130, and 140 Volt Central Office Power plant Rectifiers, Issue 1, May 1985
Bellcore TR-EOP-000154	Generic Requirements for 24, 48, 130, and 140 Volt Central Office Power Plant Control and Distribution Equipment, Issue 1, May 1985
Bellcore TR-RSY-000043	Above Ground Electronic Equipment Enclosures (AG/EEE), Issue 1, December 1985. Reference for structural requirements and floor loading.
Bellcore TR-TSY-000026	Below Ground Electronic Equipment Enclosures, Issue 1, July 1985. Reference for structural requirements and floor loading.
Bellcore TR-TSY-000078	Generic Physical Design Requirements for Telecommunications Products and Equipment, Issue 1, October 1986.
Bellcore TR-TSY-000332	Reliability Prediction Procedure for Electronic Equipment, Issue 1, Revision 1, April 1986
Bellcore TR-TSY-000406	DC Bulk Power System for Confined Locations, Issue 1, May 1988
CSA 0.4-M1982	Bonding and Grounding of Electrical Equipment, December 1982
CSA TIL 01	Power Supplies for Use in Telephone Equipment, April 1984
IEC 555	Disturbances in Supply Systems Caused by Household Appliances and Similar Electrical Equipment
IEC CISPR PUB 22	International Electrotechnical Commission, Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment, 1985

(REFERENCES CONTINUE)

Document number	Title
IEEE 487-1992	IEEE Guide for Protection of Wire-line Communication Facilities Serving Electric Power Stations
NEC1993	National Fire Prevention Association, National Electrical Code
NEMA PV-7-1979	Communications Type Battery Chargers, National Electrical Manufacturers Association
Underwriters Laboratories UL1012	Standard for Safety: Power Supplies, April 1990
Underwriters Laboratories UL1950	Standard for Safety: Information Technology Equipment Including Electrical Business Equipment, March 1989
Underwriters Laboratories UL489	Molded Case Circuit Breakers and Circuit Breaker Enclosures, May 1984

ABBREVIATIONS

Abbreviation, acronym or symbol	Meaning
AC	alternating current
ACF	ac failure (alarm)-alarm output, issues ground
CEV	controlled environmental vaults
CM	circular mills
CSA	Canadian Standards Association
DC	direct current
EEE	Electronic Equipment Enclosures
EMI	electromagnetic interference
ESD	electrostatic discharge
FCC	Federal Communications Commission
FF	fan failure (alarm)-alarm output, issues ground
FL	full load pushbutton
GND	ground
HFM	high frequency mode (rectifier mode)
HV	remote high voltage shutdown-control input, accepts ground
HVO	high voltage shutdown occurring – alarm output, issue ground
HVSD	high voltage shutdown (alarm)
IEC	International Electrical Commission
IEEE	Institute of Electrical and Electronic Engineers
LCA	low current (alarm)-alarm output, issues ground
LED	light-emitting diode
LS	loadshare-signal input/output, 0 to 10 volts
NEBS	Network Equipment Building Safety
NEC	National Electric Code
NL	no load (pushbutton)
OSHA	Occupational Safety and Health Administration
RBOC	Regional Bell Operating Company
REMEQ	remote equalize-control input, accepts ground
RFA	rectifier failure (alarm)-alarm output, issues ground
RS	remote restart- control input, accepts ground
THSD	thermal shutdown (alarm) – alarm output, issues ground
TR	temporary release – control input accepts ground
TRO	temporary release occurring – alarm output, issues ground
TS	temperature sensor
UL	Underwriters Laboratories

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CHAPTER ONE: INTRODUCTION

GENERAL DESCRIPTION

The 24V/150A Modular Switched-Mode Rectifier withstands diverse environmental conditions, while converting input power of 208, 220 or 240 volts AC into 24 volt DC power. Four hot-swappable rectifiers mount in an 18 KW Modular Power Shelf, to provide redundant, reliable and compact power in underground controlled environment vaults (CEVs), above ground electronic equipment enclosures (EEEs), customer premise locations, and remote switch sites.

The output equalize and float voltages are adjustable from 24 to 30 Vdc and 24 to 28 Vdc respectively. C & D rectifiers can perform forced or passive load sharing with other rectifiers of similar sharing characteristics.

The rectifier has a built-in, programmable, high-voltage shutdown (HVSD) function. No single component failure (short or open) will result in an output voltage greater than 30 volts. After a remote high voltage shutdown signal is received or an internal shutdown occurs, the rectifier may be reset locally by toggling the AC breaker or applying a ground to the high voltage reset input. The rectifier may also be restarted via a controller.

STANDARD FEATURES

Switched-mode Rectifier Features

- Hot-swappable and lightweight modules allow a low mean-time-to-repair without system shutdown.
- Active power factor correction greater than 0.98 and efficiency of 85 percent means low operating costs.
- Designed to Bellcore Technical References allowing application in all RBOCs.
- No tools are necessary for rectifier installation.
- Front-panel rectifier failure (RFA), fan failure (FF), and AC failure (ACF) light emitting diodes (LEDs).
- Front-panel normal and equalize status indications.
- Front-panel 3.5 digit ammeter.
- Temperature compensated battery charging.
- Cooling fans are field-replaceable without system shutdown.

Eighteen-kilowatt Modular Shelf Features

- Rectifier modules can be removed from or inserted into the shelf without disrupting the system.
- Individual AC inputs to each module assure reliability of AC source.

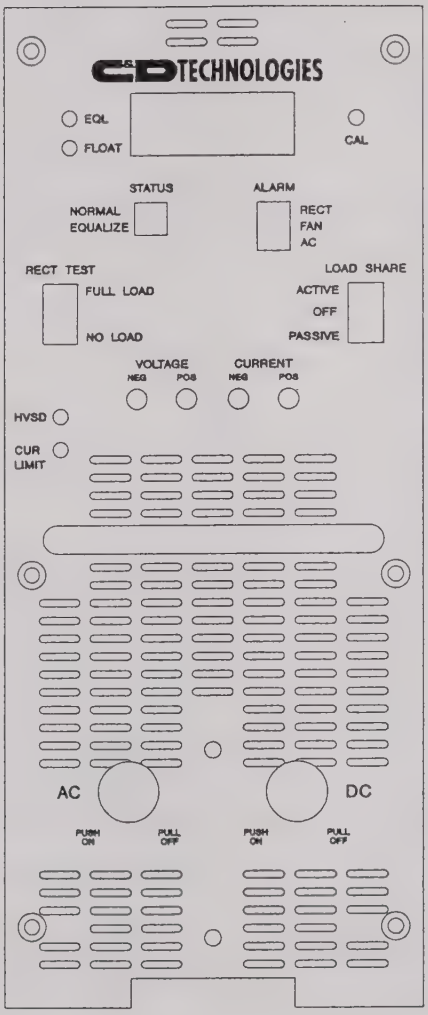

Figure 1 – 1: Front panel

MONITORING AND CONTROL FEATURES

Five LED's on the front panel of the rectifier alert operators of the rectifier's alarm and operating status. Eleven Form-A contacts are provided to transmit alarms to remote locations. There is a digital ammeter on the front panel, and two current shunt test points for respective local and remote current monitoring. The rectifier accepts seven analog or ground inputs from the plant controller. All input and output contacts, and front panel indicators are detailed in the following table.

FRONT PANEL INDICATOR	REMOTE SIGNALLING DEVICE	CAUSE OF ALARM
Red RFA LED	RFA Form-A Contact OS Form-A Contact THSD Form-A Contact LCA Form-A Contact DC breaker Form-A Contact High-voltage shutdown input and Form-A output contact	A discrepancy exists between the rectifier's output power and the load condition, or one of the following conditions exists: • The sense leads are open or reversed. • The rectifier's internal temperature has exceeded an acceptable level, or airflow has been restricted, and the rectifier has shut down. • The rectifier is delivering less than two percent of its rated current ± 3 amps. • The DC breaker is off or has tripped. • The rectifier will lock itself out if it is delivering more than 10 percent of its rated load current, and it receives an HVSD signal from the plant monitor. The rectifier will also lock itself out if its terminal voltage exceeds a customer selectable threshold while it is delivering more than 10 percent of its rated load current. A HVSD signal is sent to a remote location.
Red FF LED	FF Form-A Contact	Rectifier's cooling fan has failed.
Red AC LED	AC Form-A contact for signaling an AC failure	The input AC power has failed. The AC breaker is off or has tripped.
Yellow equalize LED	Equalize input and Form-A contact for signaling that the equalize mode is in use.	The operator may remotely or locally put the rectifier in equalize mode or the input AC voltage range has been exceeded (183 – 264 VAC).
Green normal LED		Rectifier is in the normal (float) mode.
3.5-inch digital ammeter	Two 37.5 mV full scale leads with resistor protection for remote current monitoring	Continuously displays current.
	AC breaker Form-A contact	AC breaker is off or has tripped
	Input to restart rectifier after a high-voltage shutdown	Operator may remotely reset the rectifier after a high-voltage shutdown.
	Temporary release input and Form-A output contact	The rectifier has received a temporarily release signal from the plant monitor. The rectifier will temporarily stop delivering power. A TRO signal is sent to a remote location.
	Active load share signal	The rectifiers will share current when the load share signals for all rectifiers have been connected together.
	Two inputs for remote voltage control	The rectifier will adjust its float and equalize voltages, if it receives a signal from the plant controller.

PHYSICAL SPECIFICATIONS

	RECTIFIER	SHELF
HEIGHT	12" (30 cm) (seven rack spaces)	7" (18 cm)
WIDTH	5" (13 cm) (one power shelf slot)	21.5" (55 cm) (for 23-inch rack mounting)
DEPTH	14.5" (37 cm) (includes cooling fan)	14.5" (37 cm)
WEIGHT	25 lbs. (11.3 kg)	18 lbs. (8.2 kg)

ENVIRONMENTAL SPECIFICATIONS

Temperature Range and Humidity

The rectifier(s) and power shelf are capable of normal and continuous operation of up to 28 Vdc output with in an ambient temperature range of 0 to 50 C (32 to 122 F), with relative humidity up to 95 percent, non-condensing. The equipment may be safely stored in temperatures ranging from –50 to 85 C (-58 to 185 F), with relative humidity up to 95 percent, non-condensing.

Altitude

The rectifier and power shelf are capable of normal operation in altitudes ranging from sea level to 13,000 feet (3,692 meters). Derating begins above 5,000 feet (1,524 meters).

Heat Dissipation and Cooling

Heat will dissipate from the front to the rear of the rectifier via forced air circulation. No heat baffling is required between power shelves.

Earthquake

The rectifier is capable of operating during and after earthquakes characteristic of seismic zone 4 as per TR-EOP-000063 and the Uniform Building Code 1982.

Electromagnetic Interference (EMI)

The rectifier meets FCC Part 15, Subpart J, Class A, VDE-0875, Class N conducted emissions, TA-NWT-001089 and CISPR Pub 22 Class A.

Electrostatic Discharge

The rectifier meets TR-NWT-000063 and will not sustain any damage with application of 20,000 volts. Further, the rectifier will experience, at most, consequential momentary disturbance with up to 4,000 volts and no effect below with up to 2,000 volts application.

ELECTRICAL SPECIFICATIONS

Input Voltage Supply

The rectifier is rated for 208 or 240 Vac input, accepting an input range from 183 to 264 Vac.

Input Current per Rectifier

Line	27V/150A	28V/150A
240 Vac	20.0 A	20.6 A
208 Vac	23.7 A	24.0 A

Efficiency

Efficiency will be greater than 85 percent, outputting 150 amperes at 28 volts from a 240 Vac input at 25 C, and greater than 50 percent outputting 15 amperes at 28 volts from a 240 input at 25 C.

Frequency

45 to 65 Hertz (50 or 60 Hz nominal)

Power Factor

The power factor will be greater than 0.98 at rated output.

Total Harmonic Distortion (current)

Input current total harmonic distortion will be less than five percent, meeting IEC 555 requirements

Single Harmonic Amplitude (current)

Harmonic amplitude will be less than three percent of the fundamental, meeting IEC 555 requirements

Output Rated Voltage

The rectifier is rated for a 24 Vdc output.

Output Float Voltage Range

The output float voltage range is adjustable from 24 to 28 Vdc.

Output Equalize Voltage Range

The output equalize range is adjustable from 24 to 30 Vdc with HVSD circuit disable.

Output Current

The output current is 150 amperes and is adjustable.

Regulation

The rectifier maintains output voltages at the regulation point of ±0.5 percent over all input and output requirements and ±1 percent under all input, output and environmental requirements between 0 and 50 C (32 to 122 F).

Dynamic Response

During any step load change from 5 to 95 percent or from 95 to 5 percent of the nominal current over a 50 uS time period, the output voltage shall not overshoot or undershoot more than five percent and shall return within regulation before one millisecond of time has elapsed.

Input Protection

The rectifier and the AC source are protected via a two-pole circuit breaker provided with the rectifier.

Output Protection

The rectifier and the load are protected via a one-pole DC circuit breaker, and the internal high voltage shutdown function.

Current Limiting

The rectifier will automatically current limit at no more than 110 percent of the rectifier's rated current or 165 amperes.

Walk-on Current

When the rectifier is turned ON, a gradual increase of output current eliminates excessive DC voltage overshoots or load step on AC source. Walk-on will occur in not less than eight seconds from NO load to FULL load.

Warm-up Time

The rectifier takes less than one hour to warm-up and will experience no more than 5 percent voltage drift during warm up.

Voltage/Temperature Coefficient

The voltage/temperature coefficient will be less than 0.01 percent per degree Celsius.

Stability

The rectifier does not present any oscillation or instability under any of the input, output and environmental conditions of operation specified. The phase margin is greater than 30 degrees and the gain margin is greater than 12 dB.

Grounding

The rectifier will be grounded via a plug to the power shelf and the power shelf will be provided with a ground terminal for the central office grounding.

Electrical Isolation

The outputs are electrically isolated from the input AC terminals.

NOISE SPECIFICATIONS

High Frequency Noise

High frequency output noise will not exceed 40 millivolts rms, and the peak-to-peak ripple (including switching spikes) will not exceed 350 millivolts for all operating conditions except temperatures below 0 C (32F), measured with a 20 megahertz scope.

Voice Frequency Noise

The voice frequency noise does not exceed 32 dBrnC for battery or batteryless operation under all environmental, input, and output conditions, not withstanding a minimal load of one-percent.

Acoustical Noise

Acoustical noise will not exceed 62 dB with "A" message weighting measure five feet above the floor and two feet from the plant while operating any load, per Bellcore TA-NWT-000406.

SAFETY SPECIFICATIONS

Materials used in the rectifier and power shelf present no thermal, environmental, or other safety hazard, as defined by current industry standards or applicable federal, state, or local laws and regulations. They are meant for use in accordance with the requirements of the Federal Communications Commission (FCC), the National Electric Code (NEC), the Underwriter's Laboratories (UL), the Department of Labor's Occupational Safety and Health Administration (OSHA), and any other applicable federal, state, or local requirements imposed by ordinance or law.

The rectifier and power shelf meet or exceed all fire resistance requirements, as specified in Section 4.3 of TR-EOP-000063, *Network Equipment-Building System (NEBS) Generic Equipment Requirements*.

UL, Canadian Standards Association (CSA) and International Electrical Commission (IEC) certification is pending.

TROUBLESHOOTING

This section lists some helpful hints on how to analyze problems that may occur. If the following information does not solve your problem, contact C & D Field Service at 1-800-873-2707.

	Possible Causes
*The display does not light	The rectifier is not receiving AC power. Make sure the AC breaker on the front panel is pushed ON. Check the AC cabinet breakers.
*The RFA LED is illuminated	The DC breaker if OFF. Make sure the DC breaker on the front panel is pushed ON.
	The breakers are open in the AC cabinet. Reset as required.
	The float voltage is improperly set. Readjust as necessary.
	The rectifier is delivering less than two percent of its rated current.
	A high voltage shutdown has occurred. Pull the front panel breakers OFF. Allow the fan and digital ammeter to de-power and then reengage the breakers. Verify no HV signal is present.
	The sense leads are open or reversed. Check them.
	An excessive ambient temperature is present. Rectifier will restart when the temperature returns to the normal range.
	If the FF LED is also illuminated, the fan has failed. Replace it.
	The airflow is blocked. Clear the area behind the rectifiers of blockage. Clean the rectifier faceplate of dust and lint.
*Fan Fail (FF) LED is illuminated	The fan has failed or reduced speed. Replace the fan. Unit will shutdown and display FF &RFA condition.
*AC LED is illuminated	The AC voltage is out of the allowable range. Correct the AC voltage.
	An AC breaker is open on the rectifier or in the AC service cabinet. Reset as necessary.
*Greater than 0 amperes register when the NL button is pressed.	The plant current is higher than N-1 rectifiers.
*Less than 50 amperes register when the FL button is pressed.	Total plant current is less than 50 amperes.

Possible Causes

*Rectifiers don't loadshare properly

- The loadshare mode is not properly set. Set all rectifiers to passive or active and rebalance the plant.
- The ammeter is out of calibration. Readjust the ammeter by comparing its readings to the current test jacks.
- An alarm condition is present on the rectifier(s) not load sharing properly. Correct the problem causing the alarm and rebalance the plant if necessary.

CHAPTER TWO: INSTALLATION

GENERAL

These instructions provide general information about installing 24V/150A Modular Switched-Mode Rectifiers into the Eighteen-Kilowatt Modular Power Shelf. Please reference the power plant product manual for further information concerning inserting the power shelf into the power plant.

If you have any questions or problems during installation, please call our technicians at 1-800-873-2707 for assistance. There is an identifying number on the front of the rectifier. Please reference this number when requesting service.

The following tools and test equipment are recommended for installing shelves and rectifiers:

- ✓ equipment to remove shipping containers
- ✓ safety glasses
- ✓ anti-static wrist strap
- ✓ crimping tool
- ✓ pliers, cutters, and screwdrivers
- ✓ tie-wrap, twine, or friction tape
- ✓ multimeter with clamp-on meter (true rms)

RECEIVING AND PLACING

1) Before opening the packages, carefully inspect the exterior for signs of mishandling. If the packaging appears damaged, file a damage claim with the shipping carrier.

2) Use appropriate equipment to uncrate the rectifier(s) and power shelf, to ensure the safety of personnel and equipment. Uncrate in an area large enough to accommodate shipping crates and equipment.

3) Carefully remove equipment from packing, and examine to verify that the equipment is complete and undamaged.

4) Store shipping crate. If the equipment is returned to C & D, it must be shipped in the original packaging.

5) Equipment will last longer if it is kept in a non-harmful environment. Select a permanently secured location that is :

   - DRY
   - WELL VENTILATED
   - FREE OF OBSTRUCTIONS
   - PEST FREE

SELECTING POWER CABLES

Protective circuits, overall system performance, and safety depend on the proper sizing of DC cables for ampere ranges and acceptable DC voltage drop.

Perform the following procedure to determine wire size.

PROCEDURE

1) Calculate the minimum number of circular mils (CM) required for copper wire using the following formula:

$$CM = \frac{22.2 \times I \times L}{V}$$

Where:
CM= minimum area of circular mils in the cable
I= maximum current (in amps)
L= one-way cable length (in feet)
V= allowable loop voltage drop (in volts)

i.e.: If you have a maximum output current of 100 amperes, and an allowable loop voltage drop of 0.25 volts, and your power plant is 50 feet from the load:

I= 100 amperes
L= 50 feet
V= 0.25 volts

$$CM = \frac{(22.2)(100)(50)}{(0.25)}$$

CM = 440,000

2) After calculating the minimum number of circular mils, select the proper copper wire size from Table 2-A, always choosing the larger wire if the resistance rating falls between values.

3) Determine the minimum wire size for ampacity according to the code authority having jurisdiction over your location.

4) Select the larger of the sizes calculated for voltage drop or ampacity.

Size AWG No.	Area in cm	Current carrying capacity*	Dia bare cond inches	RHW Dia over ins inches	RHW Bend radius inches	RHW net weight per 1,000 feet in pounds	RHW maximum ship lengths per reel in feet
14	4110	15	0.064	0.19	0.95	26	5000
12	6530	20	0.081	0.21	1.05	35	3000
10	10380	30	0.102	0.24	1.2	49	3000
8	16510	45	0.146	0.31	1.55	84	3000
6	26250	70	0.184	0.4	2	126	2000
4	41740	100	0.232	0.45	2.25	190	1500
2	66370	135	0.292	0.51	2.55	278	1000
1/0	105500	185	0.373	0.63	3.15	443	1000
2/0	133100	210	0.418	0.68	3.4	540	1000
4/0	211600	300	0.528	0.78	3.9	814	1000
350 MCM	350000	425	0.681	0.98	4.9	1310	750
500 MCM	500000	525	0.814	1.12	5.6	1815	500
750 MCM	750000	660	0.998	1.34	6.7	2700	360

Table 2-A: Determining wire sizes

*Data based on NEC Handbook 1993, Table 310-17 adjusted for 50 C ambient temperature.

WIRING AC INPUT TO THE POWER SHELF

NOTE: If you have ordered the AC cord pigtail option, skip the following procedure. Simply terminate each AC cord with a mating twist-lock receptacle in a convenient, accessible location within the twenty-foot pigtail's reach.

NOTE: The access holes for AC cords in the power shelf should be wired from top to bottom corresponding to slots four through one. (Slot four is the slot furthest from the AC cord access holes.) If the first slot will be used to house a distribution module, do not wire that slot, and leave the topmost access hole empty.

PROCEDURE

1) Protect input cables by installing a circuit breaker with a minimum 40 ampere capacity on each input cable.

2) Run individually protected cabling leads from the AC source to the cabling channel on the left side of the power shelf.

3) There are four conduit holes on the side of the power shelf to correspond to the four slots in the shelf. The uppermost hole corresponds to the slot to the far right, and the lowest conduit hole corresponds to the slot to the far left.

NOTE: Due to limited internal wiring access, proper cabling is important. Be sure to wire according to the instructions in Step 3.

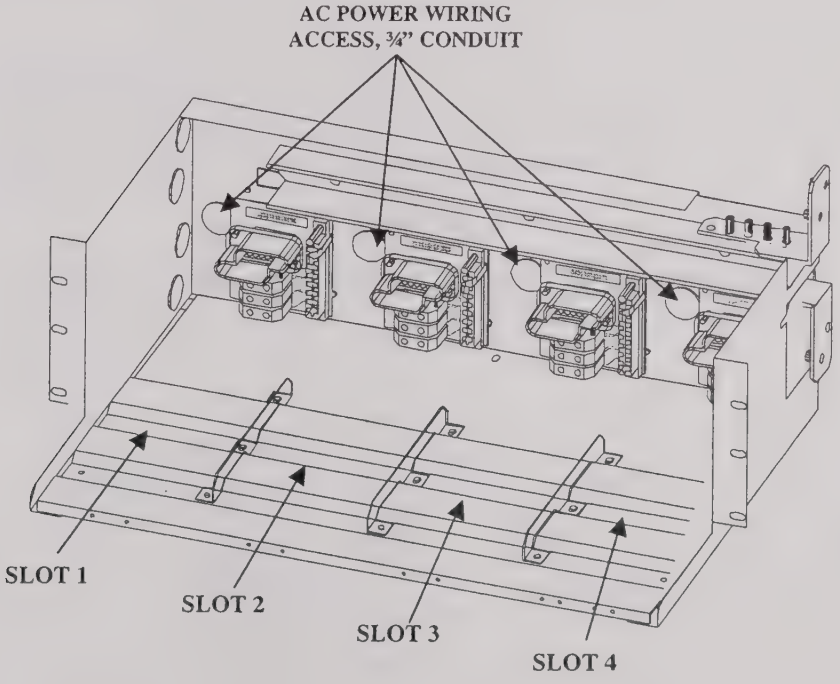

Figure 2-1: Eighteen Kilowatt Modular Power Shelf

4) Working your way from left to right, connect the leads to the isolated terminal blocks of the individual slots of the power shelf, leaving the fourth slot unwired, if it is to be used for distribution.

5) Individual AC wires can be tied to the cable guides with tie wraps.

6) Applying a meter to individual terminal blocks, verify that AC input voltage is between 183 and 264 volts AC.

7) Check breakers at the AC breaker cabinet. Verify that they are OPEN, and that the AC power is disconnected. Power should remain disconnected from the shelf until the rectifiers are installed.

INSTALLING RECTIFIERS

WARNING : The rectifier modules provide a simple locking handle that cams the module into the installed position. Excessive force is unnecessary for installation, and could result in mechanical damage to the rectifier module.

WARNING : All power shelf slots must contain a rectifier, a distribution module, or a protective cover. Do not insert arm or tools into power shelf slots.

The modular rectifiers are designed to be installed hot with no plant service interruption. Rectifiers are shipped separately in padded boxes. Blank covers have been installed in all power shelf slots.

PROCEDURE

1) Remove rectifiers from shipping containers. Remove all packaging materials.

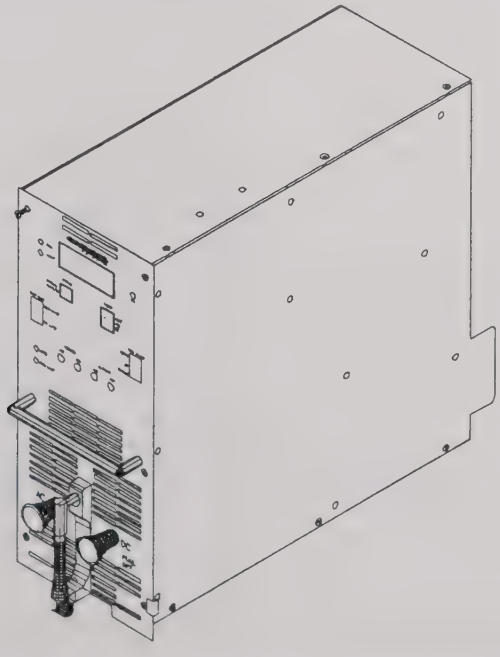

Figure 2-2: 24V/150A Modular Switched-Mode Rectifier

2) Remove blank covers from the power shelf slots.

3) Pull AC and DC breaker handles on the front of the rectifiers OUT.

4) Open the locking handle into the horizontal position.

5) Slide a rectifier slowly into the left most power shelf slot to be used for rectifiers until the locking handle engages. The rectifier will come into its operating position as the handle is moved into its locking position.

6) Install rectifiers into the power shelf slots from left to right, leaving the blank covers in place over any unused slots. The removed covers can be stored for possible maintenance use.

POWER – UP THE RECTIFIERS

PROCEDURE

1) Turn on the AC mains at the service cabinet.

2) Confirm line-line voltage is 208 Vac or 240 Vac nominal when measured at the AC connector in the rectifier slot.

3) Repeat for each rectifier slot to be activated.

4) Insert the rectifiers in their respective slots.

5) Turn off the AC breaker and engage all DC breakers to be activated. Set load share switches to OFF.

6) Close the AC breaker on one of the rectifiers.

7) Using the front panel voltage test jacks, adjust the rectifier float voltage to 27.0 Vdc.

8) Repeat steps 4 through 7 for each rectifier to be activated.

9) Adjust the individual rectifier float voltages and load bank as required until the rectifiers take load and are set to roughly 27 VDC (± 1/2V). It may be necessary to connect the load by pushing the "NORM" or "RECONNECT/INHIBIT" switches on the LVD if present.

10) Finely adjust rectifier float voltage settings as necessary until the rectifiers are sharing current (± 15 ampere) and the plant voltage is 27.0 Vdc.

11) If forced loadshare is desired, place all loadshare switches in the ACTIVE position.

NOTE: Active loadshare is broken when an RFA occurs due to low current. In this case, press FL momentarily to re-engage active loadshare.

At this point, the rectifier ammeters should show current delivery and all rectifier LED's except NORMAL should be off.

VERIFICATION OF PROPER RECTIFIER INSTALLATION

PROCEDURE

1) Adjust the plant current to approximately 75 amperes.

2) Pull OUT the AC and DC breakers in one rectifier.

3) Push ON the AC breaker after the rectifier display goes out.

4) Monitor the rectifier output voltage (independent of the charge bus) at the rectifier voltage test jacks.

5) Confirm the internal high voltage shutdown occurs at the proper DC voltage value by gradually increasing the rectifier float voltage until the rectifier shuts down.

6) Restart the rectifier by reducing float voltage slightly and pulling OUT the AC breaker until the rectifier display goes out.

7) Push ON the AC breaker and allow 30 seconds to power-up. Then push ON the DC breaker.

8) Readjust the float voltage until the rectifiers share current.

9) Perform steps 2 through 8 for each rectifier in the plant.

10) Confirm and if necessary, calibrate the digital meter. The voltage at the "current" test jacks in millivolts multiplied by 4.0 should equal the current display by the meter. Calibration will be most accurate when done at full load.

11) Push the load share switch into the PASSIVE position on all rectifiers.

12) Finely adjust the float voltage on each rectifier as required to achieve current balance between rectifiers and maintain correct float voltage.

13) Vary the output load to confirm loadshare and output voltage regulation.

14) Push the load share switch into the ACTIVE position on all rectifiers.

15) Finely adjust the float voltage on each rectifier as required to achieve current balance between rectifiers and maintain correct float voltage.

16) Vary the output load to confirm loadshare and accurate output voltage regulation.

17) Exercise the regulation circuitry by momentarily pushing the rectifier test switch into the FL and then NL position on each rectifier. Note that FL and NL may not be effective with light or extremely heavy plant loads.

18) Increase the plant load to more than 150 amperes.

19) Confirm the current limit setting of each rectifier by pushing the rectifier test switch into the FL position and holding it there for a few seconds. The instantaneous current limit is displayed first, followed by the average current limit. The instantaneous current limit is set at approximately 165 and is nonadjustable. The average current limit is adjustable up to 150 amperes.

20) If necessary adjust the average current limit by adjusting the current limit potentiometer while holding the rectifier test switch in the FL position.

The plant may now be placed in service. Please refer to the plant manual for further operational or configuration information.

CHAPTER THREE: OPERATION

OPERATION

There are two switches on the front panel of the rectifier; the rectifier test switch and the load share switch.

Rectifier Test Switch

Use the front panel RECT TEST switch to test the rectifier. The meter should register an increase in sourced current when the switch is in the FULL LOAD position. The meter should register a decrease in sourced current when the switch is in the NO LOAD position. Press FULL LOAD momentarily if the rectifier shows zero current while loadsharing is active. This will override the alarms and reengage the loadshare.

Load Share Switch

The front panel LOAD SHARE switch has three positions: ACTIVE, OFF, and PASSIVE.

- Active Load Share:
  The active load share mode can only be used when loads are being shared with other C & D 24V/150A Switched-Mode Rectifiers (part numbers that begin with 100-7520). The active load share mode provides better regulation than the passive mode. To adjust rectifiers to active load sharing, put the load share switch in the ACTIVE position on each rectifier. Finely adjust the float voltage on each rectifier as required to achieve current balance between rectifiers while maintaining correct float voltage.

- Passive Load Share:
  The passive load share mode may be used when sharing loads with any rectifiers capable of passive load sharing. To adjust rectifiers to passive load sharing, put the load share switch in the ACTIVE position on each rectifier. Finely adjust the float voltage on each rectifier as required to achieve current balance between rectifiers while maintaining correct float voltage.

- Load Share Off:
  Put the load share switch in the OFF position when you are making adjustments to the rectifier, or if you choose not to use the load share function.

Re-energizing Rectifiers after a High-Voltage Shutdown condition OR if the DC Plunger has been physically disengaged while in operation

PROCEDURE

1. Open the AC and DC plungers on the rectifier and allow the display to fade away.

2. Adjust the float voltage potentiometer on the face of the rectifier six (6) full (counter-clockwise) revolutions.

3. Put rectifier load share switch in the PASSIVE or OFF position.

4. Attach a hand held voltmeter (set for DC voltage scale) to the voltage test jacks, which are located on the front of the rectifier.

5. Energize the AC plunger on the front of the unit. See that you get display and check for the operation of the fan.

6. Adjust the float voltage potentiometer (clockwise) until the DC voltage is close or matches the other operational units. (use hand held meter for this adjustment)

7. Energize the DC plunger on the front of the rectifier. Fine tune the float voltage until the rectifier current is within (plus or minus) 10 amps of the other modular rectifiers in the plant.

8. Set load share switches on each rectifier to the active position.

*NOTE: If this procedure fails to bring the rectifier back on line; please contact Field Service at 1-800-873-2707.

ADJUSTMENTS

Float and Equalize Voltage Adjustments

There are two adjustments to the left of the digital meter on the front panel of the switched-mode rectifier, labeled EQL and FLOAT. These are used to adjust the equalize and float voltages respectively. Turning the adjustment clockwise will increase voltage output. Turning the adjustment counterclockwise will decrease voltage output. To adjust the float or equalize voltage, put the load share switch in the OFF position, plug a high-quality voltmeter into the test jacks, and adjust the float or equalize adjustments until the desired setting is displayed on the voltmeter.

If the rectifiers are operating in parallel, adjustments must be made to all of the rectifiers, keeping the current balanced between the rectifiers. Make small adjustments to each rectifier until the desired float or equalize voltage is displayed on the voltmeter *and* the ammeters all display the same amperage values.

High-Voltage Shutdown (HVSD) Adjustment

The high voltage shutdown voltage can be adjusted and the shutdown function exercised on-line without disturbing the bus voltage. There is a HVSD adjustment on the front panel of the rectifier. To adjust the voltage at which the rectifier shuts down, perform the following procedure.

PROCEDURE

1) Turn the HVSD adjustment fully clockwise.

2) Pull the DC breaker knob into the OFF position. The rectifier may shutdown. If so, pull the AC breaker knob into the OFF position, wait for the display lights to extinguish and the fan to stop, and then push the AC breaker knob into the ON position.

3) Plug a high-quality voltmeter into the test jacks.

4) Set the float adjustment to the voltage level at which you want the rectifier to shutdown.

5) Slowly turn the HVSD adjustment counterclockwise until the rectifier shuts down.

6) Turn the float adjustment counterclockwise a few turns.

7) Pull the AC breaker knob into the OFF position.

8) Allow enough time to pass for the display lights to extinguish and fan to stop rotating.

9) Repeat this procedure until the HVSD is properly set.

10) Restart the rectifier with the DC breaker knob remaining in the OFF position.

11) Reset the float voltage.

12) Push the DC breaker knob into the ON position.

13) Readjust the float voltage to balance the rectifier currents.

Current Limit Adjustment

The rectifier will automatically current limit at no more than 100 percent of the rated current or 150 amperes. To adjust the current limiting value, push the rectifier test button into the FULL LOAD position, and adjust the current limit (CUR LIM) adjustment until the meter reads the desired setting, up to a maximum of 150 amperes.

NOTE: If the plant current is less than the desired current limit point, the current limit cannot be adjusted.

Meter Calibration

Attach a voltmeter that displays millivolts to the current test jacks. Adjust the calibration (CAL) adjustment until the meter reading in amperes is 4.0 times the test-jack (in millivolts).

CHAPTER FOUR: MAINTENANCE, SPARE PARTS, & ACCESSORIES

MAINTENANCE PROCEDURE

Perform the following maintenance procedure twice a year.

PROCEDURE

1) Verify all rectifiers are on-line with their DC breakers pushed ON. Compare the plant's controller reading for battery voltage to the reading gained from the rectifier voltage test jacks. Calibrate the controller if necessary.

2) Compare the individual rectifier current readings displayed on the controller channels to the actual rectifier meter readings. Calibrate the controller if necessary.

3) If load requirements allow, remove rectifier modules one at a time. Use low pressure air to clean units if possible.

4) Verify proper load sharing between rectifiers and adjust if necessary.

5) Check the rectifier current reading against the current test jack reading.

6) Clean dust and lint from fans.

SPARE PARTS

We recommend that rectifiers and cooling fans are stocked as spares, for hot –swappable replacement in case of a failure.

ACCESSORIES

AC cord pigtails for AC wiring may be ordered from C & D Technologies, Inc. by part number 385-5645-00.

ENGINEERING NOTES:

51. EXTERNAL RECTIFIER SIGNAL CONNECTIONS.
EXTRA INTERFACE CIRCUITRY REQUIRED.

24V & 48V UNITS

AUTOMATIC RESTART (RS)
AUTOMATED TEMPERATURE COMPENSATION (ATC)
COMMON LOAD SHARE (LS)
DC CIRCUIT BREAKER OPERATION (DC BKR)
EQUALIZE INPUT (EQ)
OPEN SENSE ALARM (OS)
RECTIFIER FAILURE ALARM (RFA)
RECTIFIER OUTPUT CURRENT SHUNT MONITORING (SH)
SENSE LEADS (VREG+/VREG-)
THERMAL SHUTDOWN ALARM (THSD)

48V UNITS ONLY

AC FAILURE ALARM (ACFO)
FAN FAIL (FF)
EMERGENCY POWER OFF (EPO)
EQUALIZE MODE (EQO)
HIGH VOLTAGE SHUTDOWN (HVSD)
TEMPORARY RELEASE (TR)

52.

ALARM INDICATIONS		
LEAD DESG.	CAUSE	TYPE ALARM
RFA	RECT FAILED	MINOR
2 OR MORE RFA'S	RECT FAILED	MAJOR

53. A LONG DELAY BRANCH BREAKER ON AC INPUT IS RECOMMENDED, SEE INSTALLATION NOTE 1.

54. ALARM RELAY CONTACTS ARE RATED:
2A AT 28VDC, 1A AT 60VDC, AND 1/2A AT120VDC.

55. CIRCUIT BOARD 306.2771.02 HAS A RESISTOR IN RFA SIGNAL.
THIS BOARD IS USED WITH 301.2795.02 CONTROL BOARD.

RECTIFIER SHELF OPTIONS: TABLE A

POWER SHELF	VOLTAGE	DC OUTPUT	CIRCUIT BOARD	AC FEED	USAGE	ALARMING	COMMENTS
111.3785.03A	24	BUS	306.2771.02	INDIVIDUAL	ACM	RIBBON CABLE	
111.3785.07A	24	BUS	306.2771.02	DUAL	ACM	RIBBON CABLE	111.3785.03A WITH AC BO
111.3785.08A	24	BUS	306.2771.02	SINGLE	ACM	RIBBON CABLE	111.3785.03A WITH AC BO
111.3785.13A	24	BUS	306.2771.02	INDIVIDUAL	ACM 1200I/IE	RIBBON CABLE	MOUNTING POSITION FOR 12
111.3785.12A	24	CABLE W/ 3/8 LUGS	306.2771.01	INDIVIDUAL	CUSTOM SYSTEM	DB-25 HARNESS	
111.3785.32A	24	CABLE W/ 3/8 LUGS	306.2771.01	INDIVIDUAL	CUSTOM SYSTEM	RIBBON CABLE	
111.3785.02A	24	CABLE W/ 3/8 LUGS	306.2771.02	INDIVIDUAL	ACM 1200L-3	RIBBON CABLE	
111.3785.34A	48	BUS	306.2771.01	INDIVIDUAL	CUSTOM SYSTEM	RIBBON CABLE	
111.3785.04A	48	BUS	306.2771.02	INDIVIDUAL	AGM	RIBBON CABLE	
111.3785.05A	48	BUS	306.2771.02	SINGLE	AGM	RIBBON CABLE	111.3785.04A WITH AC BOX
111.3785.06A	48	BUS	306.2771.02	DUAL	AGM	RIBBON CABLE	111.3785.04A WITH AC BOX
111.3785.00A	48	CABLE W/ 1/4 LUGS	306.2771.01	INDIVIDUAL	CUSTOM SYSTEM	RIBBON CABLE	
111.3785.11A	48	CABLE W/ 1/4 LUGS	306.2771.01	INDIVIDUAL	CUSTOM SYSTEM	DB-25 HARNESS	

INST

1.

DC VOLTS
24V
48V

2. Ø M

3. TI O

4. DC OU W (S

5. CH CU

6. TH FO

ALLATION NOTES:

WER SHELF REQUIRES AC POWER CONNECTIONS
SHOWN IN TABLE "B".

TABLE B

AC INPUT REQUIREMENTS PER RECTIFIER				
VOLTS		GA	MAX AMPS	MIN BKR
176-264 VAC	L	8	30A	40A PER RECTIFIER
1 PHASE	L	8		
ACEG		8	---	---
176-264 VAC	L	8	20A	30A PER RECTIFIER
1 PHASE	L	8		
ACEG		8	---	---

WIRE IN ARMORED CABLE OR RIGID CONDUIT
TO MEET ELECTRICAL CODES.

DENOTES LEADS RUN BY INSTALLER/CUSTOMER.
NUFACTURER DOES NOT SUPPLY THE WIRE.

E RECOMMENDED HARDWARE KIT FOR RACK MOUNTING
THE POWER SHELF IS P/N 385-2933-06.

NOT USE SCREWS LONGER THAN 3/4" FOR DC POWER
TPUT CONNECTIONS TO MAINTAIN ADEQUATE CLEARANCE
TH CHASSIS. POWER SHELF 111.3785.13A USE 3/8-16 X 1
E TABLE C)

CK INTERNAL AC POWER WIRE ROUTING FOR ADEQUATE
ARANCE WHEN RECTIFIERS ARE INSTALLED.

POWER SHELF ASSEMBLY INCLUDES BLANK COVERS
EACH RECTIFIER SLOT.

DC POWER CONNECTIONS:

TABLE C

DC VOLTS	HARDWARE	CABLES
24V	3/8-16 X 3/4" BOLT	(2) 4/0 CABLES
48V	1/4-20 X 3/4" BOLT	2/0 CABLES

SHEET NUMBER	ISSUE NUMBER								
	1	2	3	4	5	6	7	8	9
1	1								
2	1								
3	1								

ISSUES

ISSUE #	DESCRIPTION	ISS. BY ISS. DATE	APP. BY APP. DATE
1	SEE ECN 13271 Original release of documentation	KEL 03/07/01	MM 4/5/01

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES ± TOLERANCES ON:		APPROVALS	DATE
HOLES	+0.004 -0.002	DRAWN K. E. LEWIS	03/07/01
FRACTIONS	±1/32	CHECKED	4/5/01
DECIMALS (XX)	±0.020	APPROVED	4/5/01
DECIMALS (XXX)	±0.010	APPROVED	
ANGLES	±1/2°		

SQUARE CORNERS AND ANGLES ARE 90° UNLESS OTHERWISE SPECIFIED.

MATERIAL:

FINISH:

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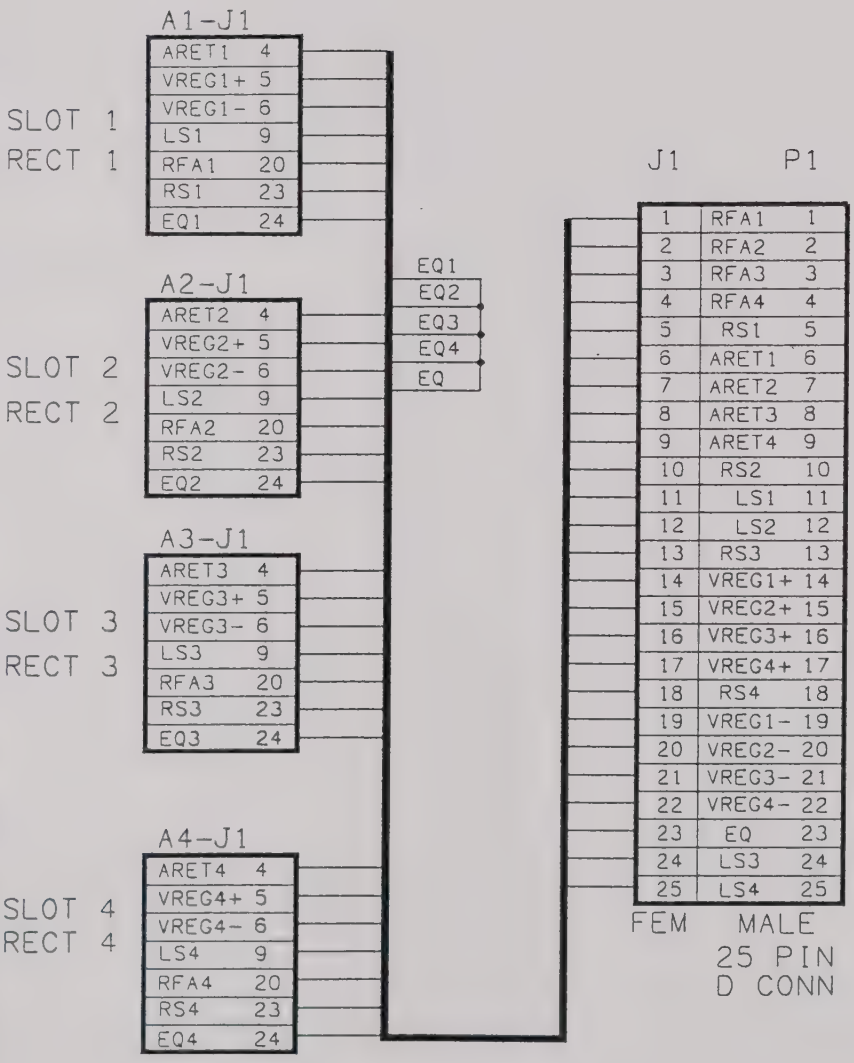
C&D TECHNOLOGIES
Power Solutions

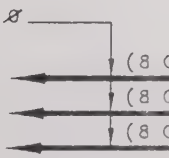
POWER SHELF ASSY. MODULAR RECTIFIERS 24VDC, 150A & 48VDC, 50A

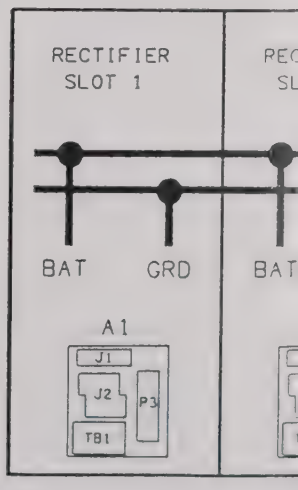
SIZE	DOC TYPE / NUMBER	ISSUE
B	PN 111-3785-	1

SCALE:	SHEET:	FILE NAME:
NONE	1 OF 3	PN111-3785_SHT_1_ISS_1

INTERNAL WIRING
RECT 1 - 4
(111-3785-11, 111-3785-12)
POWER SHELF ONLY





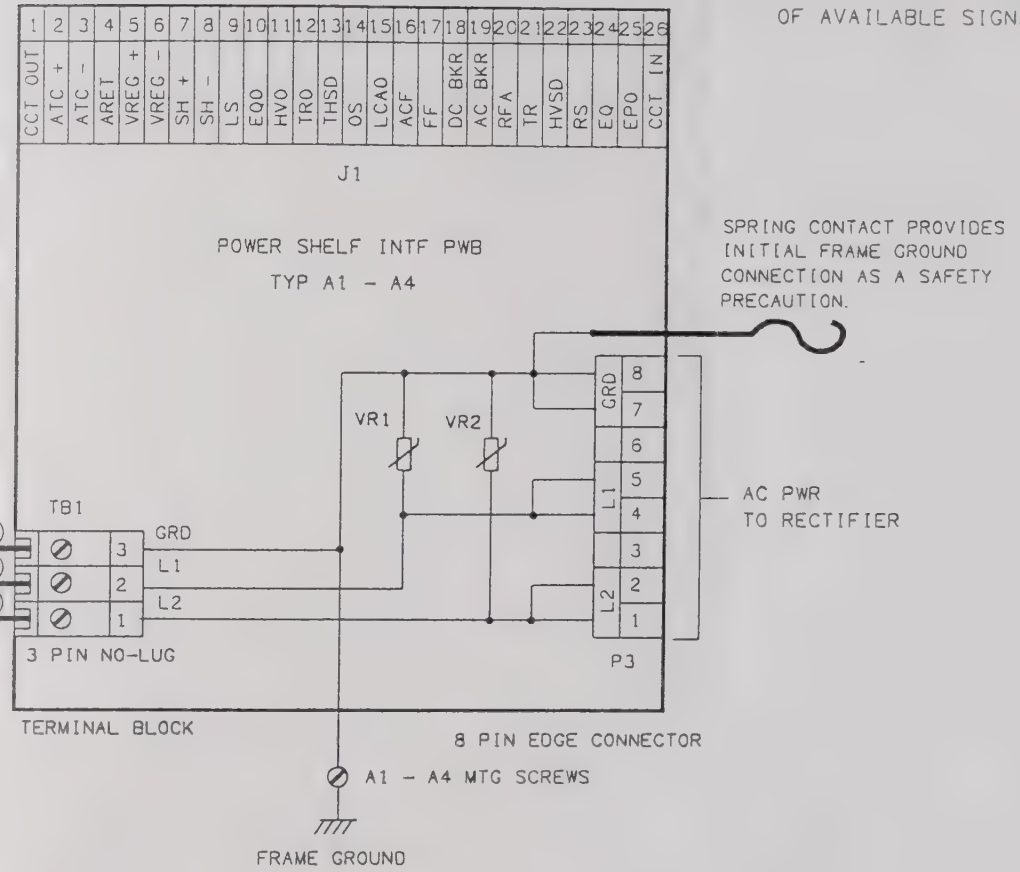


BACKPLANE BOARD ASSY
TYPICAL AC POWER WIRING SCHEMATIC

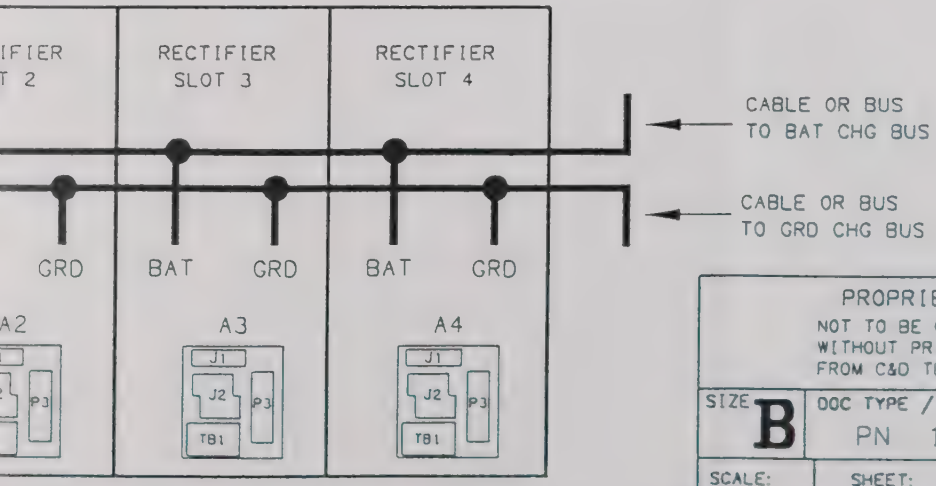
306-2771-

NOTES:

1) #1 (CCT OUT) & #26 (CCT IN) NOT USED
2) SEE NOTE 51 ON SHEET 1 FOR LIST OF AVAILABLE SIGNALS



OWER SHELF LAYOUT



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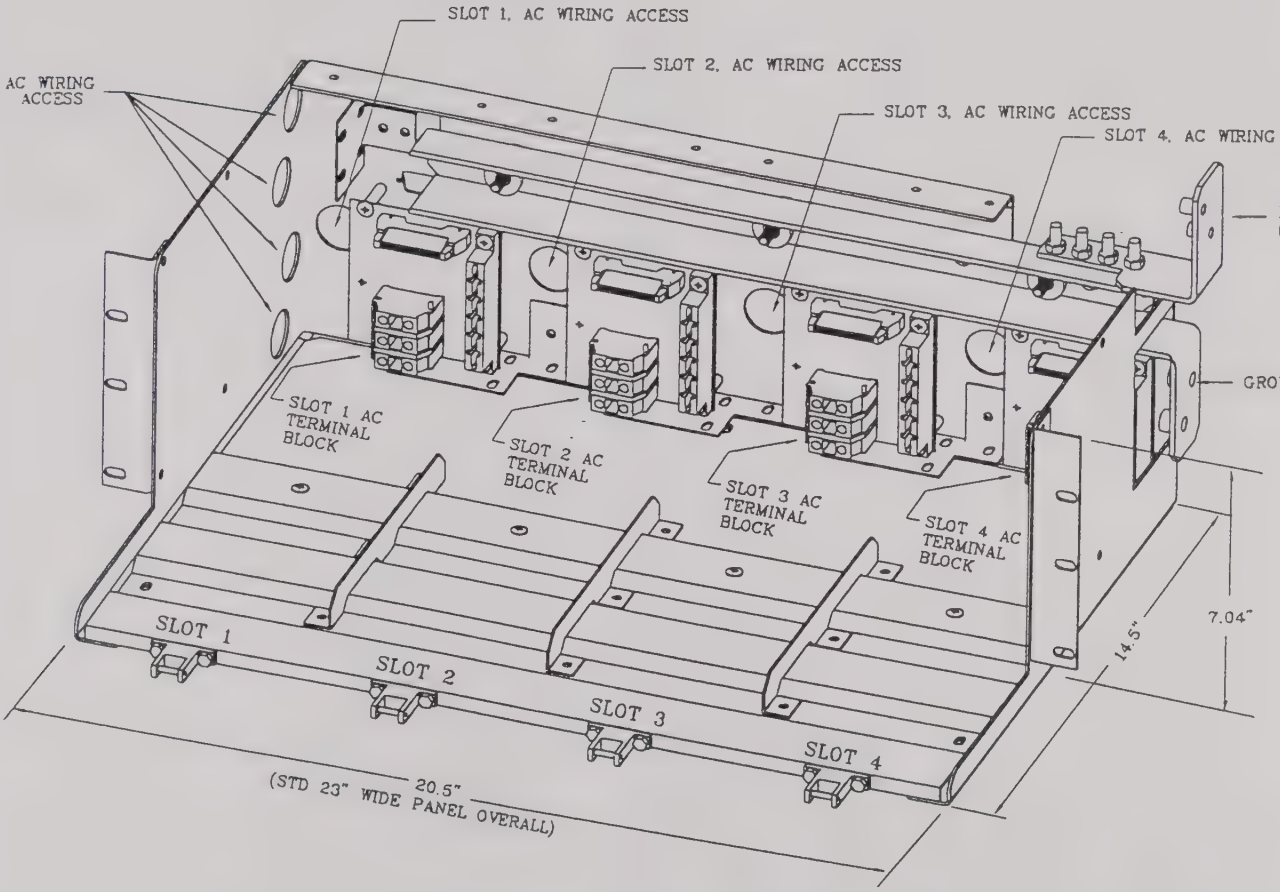
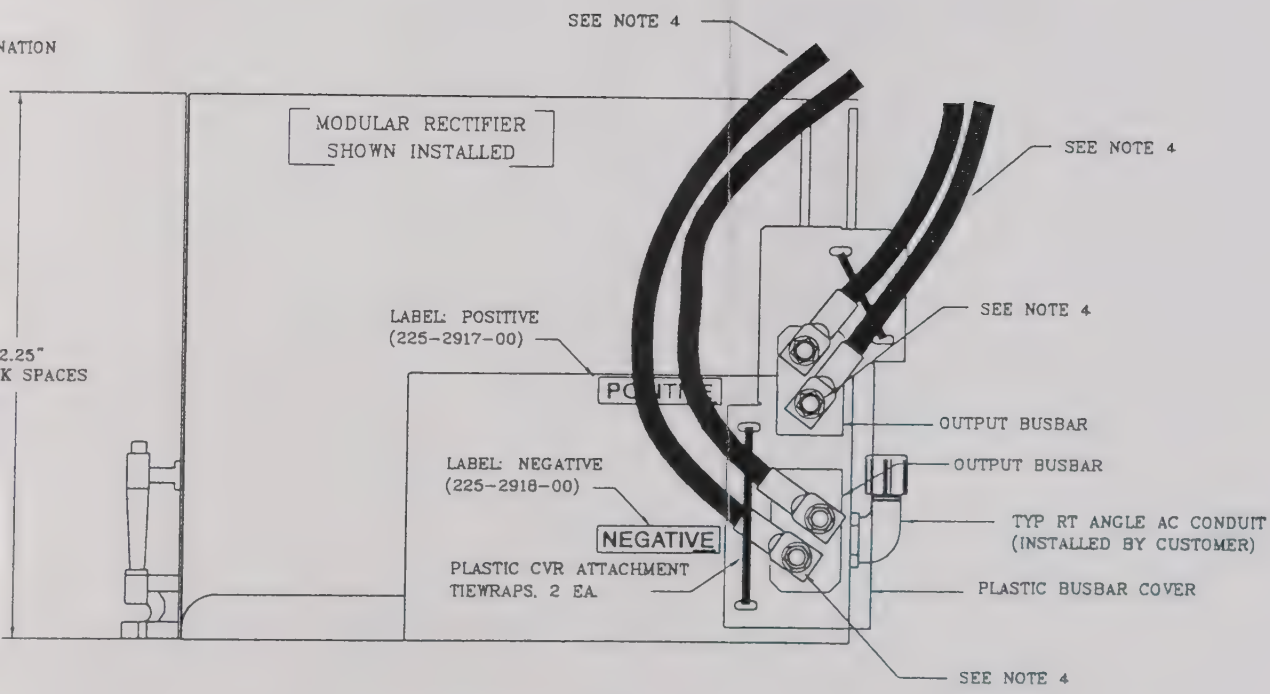


111-3785-
TYPICAL VIEW

ERMINATION

NATION

2.25"
K SPACES



POWER SHELF SIDE VIEW

TYPICAL DC POWER CABLING DETAIL

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SCALE:	SHEET:	FILE NAME:
NONE	3 OF 3	PN111-3785_SHT_1_ISS_1

C&D TECHNOLOGIES, INC.

POWERCOM DIVISION

ONE-YEAR LIMITED WARRANTY AND PRO RATA ADJUSTMENT COVERING STANDBY BATTERY CHARGERS USED IN THE U.S.A. AND CANADA

CHARGER TYPES: ARE, ARR, HRT, HFM, FC, FF, FT

WARRANTY: STANDBY BATTERY CHARGERS manufactured by or for C & D TECHNOLOGIES, INC. are warranted against defective materials and workmanship for a period of one year from date of shipment. As the sole and exclusive remedy in discharge of Warranty, C & D TECHNOLOGIES, INC. agrees if charger fails to perform its designed function when tested under C & D TECHNOLOGIES, INC. specifications for new material prior to one year from date of shipment, C & D TECHNOLOGIES, INC., at its option, will either (a) repair parts of charger at its expense for both parts and labor, FOB C & D TECHNOLOGIES, INC. destination, freight prepaid and allowed or (b) furnish a suitable replacement charger having rated capacity equal or greater than the published rated capacity of the charger returned in exchange for the unserviceable charger(s). Replacement charger shall complete only the remaining unused portion of the original warranty.

WARRANTY ADJUSTMENT AGREEMENT: The warranty covers parts replacement only. C & D TECHNOLOGIES, INC. agrees if aforementioned parts/assemblies fail, C & D TECHNOLOGIES, INC. shall replace alleged failed parts/assemblies at a cost equal to current user replacement parts price, multiplied by the months of expired warranted life, divided by 12. Freight, labor and other costs are to be borne by user. Replacement parts and assemblies are warranted for 90 days. User must give C & D TECHNOLOGIES, INC. prompt notice of alleged defects and, if requested by C & D TECHNOLOGIES, INC., return alleged defective goods to C & D TECHNOLOGIES, INC., FOB destination, freight prepaid and allowed, for evaluation.

This LIMITED WARRANTY is subject to the following terms and conditions:

1. User shall install and maintain each charger in accordance with C & D TECHNOLOGIES, INC. Installation and Operating Instructions for Standby chargers and perform all repairs using only C&D TECHNOLOGIES, INC. parts or parts specified by C&D TECHNOLOGIES, INC. in its product literature.
2. User and C & D TECHNOLOGIES, INC. shall mutually agree each charger is of the proper size, design and capacity for the duty it is to perform and will not be required to perform in excess of this agreed value during the period of this warranty.
3. Charger shall not be subjected to abuse, misuse or physical damage.
4. C & D TECHNOLOGIES, INC. representatives shall be given access to any goods subject to this Limited Warranty for purposes of inspection at reasonable hours and intervals.
5. C & D TECHNOLOGIES, INC., unless otherwise agreed, shall not be obligated to do any installation work in connection with the furnishing of new charger or repairs parts, and undertakes no responsibility for work done or expense incurred.
6. User shall not continue use of charger after discovery of defect.
7. This warranty is void if the charger becomes unserviceable due to fire, wreckage, neglect, abuse, acts of God, or if the charger has been serviced by other than C & D TECHNOLOGIES, INC. or its authorized representative.

To the extent possible, C&D TECHNOLOGIES, INC. will make available to User manufacturers' warranties for products, parts and accessories manufactured by parties other than C&D TECHNOLOGIES, INC. and supplied by C&D TECHNOLOGIES, INC., without recourse to C&D TECHNOLOGIES, INC. The foregoing is the sole and exclusive remedy in discharge of this warranty. C & D TECHNOLOGIES, INC. liability for damages, whether based upon alleged negligence, breach of warranty, breach of contract or otherwise, shall in no event exceed the purchase price of the specific item with respect to which such damages are claimed.

LIMITATIONS: This Limited Warranty Agreement extends only to original purchaser (User) and is non-transferable. Except as authorized in writing, this warranty does not cover any equipment that has been altered by any party other than C&D TECHNOLOGIES, INC. or which is not manufactured by C&D TECHNOLOGIES, INC. User shall indemnify and save C&D TECHNOLOGIES, INC. harmless from any claims and liabilities arising out of the use, maintenance, transportation, or installation of any equipment warranted hereunder. THIS LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. C&D TECHNOLOGIES, INC. MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL C&D TECHNOLOGIES, INC. BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

WARNING

At all times, safety must be considered an important factor in the installation, servicing and operation of the product, and skilled, qualified technical assistance always should be utilized.

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